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Educational Television Series 1968-69

Teachers' Guide

Mathematics
Junior Division

Educational Television Branch
ONTARIO DEPARTMENT OF EDUCATION
1670 Bayview Avenue, Toronto 17

MATHEMATICS – JUNIOR DIVISION

12 programs of 20 minutes each for students in Grades 4 - 6.

The series is in two parts. Part One, *Man and Measurement,* covers the first eight programs. The second part of the series, *Measurement in Action,* covers the final four programs.

General Introduction

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GENERAL INTRODUCTION

The series is designed for students in Grades 4-6. The aim of this series is to show that there is an underlying skill for all aspects of measurement. Students are shown that as man's need to communicate increased, so did his need for standard units of measurement. The use of standard units of measurement will be developed in a sequence starting with linear measure, and continuing with measures of surface, volume, capacity, weight, angle and temperature. In the final program, precision in measurement is shown.

This series uses a historical approach in showing students the evolution of our present system of measurement, as well as the evolution of the metric system.

The series attempts to stimulate an interest in, and an awareness of, measurement in all its phases and everyday applications. No attempt has been made to cover the practical teaching aspects of measurement which can be done more effectively in the classroom.

SERIES 1:

PROGRAM 1

INTRODUCTION TO MEASUREMENT

This program aims to interest students in all phases of measurement and introduce the need for standard units of measure.

PROGRAM CONTENT

The host, Mr. J. Whitley, presents several practical situations and demonstrates the need for measurement. The emphasis in this program is the involvement of man, through everyday situations, with all aspects of measurement. The student is shown the need for standard units on the one hand and estimation on the other.

During the course of the program several measuring instruments are used; simple devices such as a ruler, protractor, pipette and balance scale, as well as the more complicated ones such as a gas pump, micrometer, radar, and mass spectograph.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss with the students how they think man is involved in measurement.

2. Have students discuss how they themselves have been involved in measurement during the past week.

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the method used to measure the jumble of wire, (length/weight relationship), and other areas where this application could be used.

2. Discuss how man measures very small thicknesses, and how the instrument (micrometer) works. An actual micrometer would be an invaluable asset to such a discussion. The local service station could be one source of supply.

3. Using baseball as a starting point for discussion, the students could consider both the use of standard units and estimation in sports and the relative emphasis placed on each.

4. The use and the need for each of the following could be discussed by the class, or used as individual assignments:
   - radar at airports
   - balance scales
   - a gasoline pump
   - a pipette

5. On an individual or group basis students could be asked to report to the class on everyday events where measurement has been involved: length, area, volume, angle, temperature, weight (estimation and precision should be considered.)

Reference

ASIMOV, ISAAC, *Realm of Measure,* Thomas Allen & Son Ltd.

PROGRAM 2

LINEAR MEASUREMENT I

This program introduces examples of non-standard units of measurement and the development of some standard units.

PROGRAM CONTENT

Three children participate in a measuring game using non-standard measuring devices: stick, pace and chain. The results of

the game illustrate the need to select an appropriate unit of measurement.

The development of non-standard units of measurement based on body measurements such as the pace, palm, stone's throw is traced through history. The program shows the relationship between these non-standard body measurements and their modern counterparts. Again the need for standard units of measurement is emphasized by specific references.

SUGGESTED PRE-VIEWING ACTIVITIES

1. The students could discuss the meaning of linear measure.
2. As a class or group discussion, students could decide where early man most likely needed linear measure and whether standard or non-standard units would have been used.

SUGGESTED POST-VIEWING ACTIVITIES

1. As an individual assignment, students could be asked to estimate the measurement of an object within the classroom by sight, using a non-standard measurement. They could then verify their estimation by actually measuring it in the same unit as that used for the estimation.
2. Students could be asked to draw up what they feel could be a reasonable table of measures based on their own body measurements, and give reasons for their selection.

PROGRAM 3

LINEAR MEASUREMENT II

This program is designed to show why man devised various units of linear measure and also traces the historical development of some of the standard units of linear measure.

PROGRAM CONTENT

At the beginning of the program two short scenes, indicate how meaningless very large numbers are and introduces the need to reduce them to a comprehensible level. For example, feet per day is not as meaningful as miles per hour.

The historical development of our modern standard units of linear measure from the early English standards of *faedm, thushand,* is shown. In early England, the standard unit of length measurement was the arm stretch and since it was based on the human body it proved to be very useful. However, the arm stretch was not very convenient to measure the large distance between two cities or the small length or an iron nail. By agreeing on the exact length of the arm stretch, 79.20 inches, farmers, merchants and other tradesmen were able to communicate in terms of this standard unit and called this new unit, the *faedm.*

The program concludes with a review of the early standard units that are still in use today.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Students could discuss in what trades and practices early Englishmen were likely to need standard units of measure.
2. The need for a variety of standard units could be discussed, "Why not just one standard unit?"

SUGGESTED POST-VIEWING ACTIVITIES

1. The following points could be discussed from the program
   - the difficulty in using large numbers to communicate with others and the need for developing other units for linear measurement (e.g. the mile is introduced since 5280 feet involves a large number)
   - the use of the "storey" in measuring the heights of buildings and the Saturn rocket
   - the problems in using the armstretch as a unit of linear measurement
   - the need for a standard unit of measurement for farmers, merchants, carpenters, etc.
   - the present day usage of the fathom for linear measurement
   - the early English used the *thushund,* which equalled 1000 *faedms*
2. Have the students draw up a table of present-day standard and non-standard units of measure and indicate one or two of their common usages.

PROGRAM 4

LINEAR MEASUREMENT III

The aim of this program is to show students the origins and development of the metric system.

PROGRAM CONTENT

The host, reviews the fact that for a system of measurement to be of great use, it must be so structured that arithmetical operations are made as simple as possible. The simplicity of the underlying structure of the metric system is emphasized and illustrated by reference to the early English system of measurement.

SUGGESTED PRE-VIEWING ACTIVITIES

The children can refer to a table of measurements, (see prog. no. 3), or those found on the back of exercise books, and examine them for any underlying structure or pattern.

SUGGESTED POST-VIEWING ACTIVITIES

1. Use the table of early English system of linear measure, to change one unit to another, and discuss the difficulties encountered. The table is presented here for purposes of discussion.

10 fingerwidths	=	1 span
10 spans	=	1 faedm
10 faedms	=	1 chain
10 chains	=	1 furlong
10 furlongs	=	1 thushund

   Students could be encouraged to measure objects in the classroom using the above system. Simple calculations would be useful for exhibiting the relatively easy arithmetic in this system as compared to that in the present day British system of measurement.
2. Provide the students with a metric

table of linear measure and discuss the origin of unit names and what advantages and disadvantages the system has in comparison with our present system.

3. Discuss: If Canada were to go over to the metric system completely, what difficulties and problems would be encountered during, and just after, the change-over?

4. Change the following units into the unit indicated:

–	5 spans	(fingerwidth)
	8 chains	(faedm)
	5 furlongs	(span)
	2000 fingerwidths	(chain)
–	5 dekametres	(decimetre)
	50 metres	(millimetre)
	2500 centimetres	(metre)
	5 kilometres	(metre)

PROGRAM 5

SURFACE MEASUREMENT PART I

This program is aimed at introducing students to surface and its measurement.

PROGRAM CONTENT

By examining several everyday situations, the students are introduced to the meaning of surface and the need for measuring the area of the surface. The host compares the areas of plane figures by a decomposition or rearrangement method in order to establish the concept of a square unit of measure.

SUGGESTED PRE-VIEWING ACTIVITIES

1. The students could discuss the meaning of surface and area. They could refer to articles and objects in the classroom.

2. A review of squares, rectangles, and circles would give the students a better grasp of the material contained in this program.

SUGGESTED POST-VIEWING ACTIVITIES

1. Have students construct squares and rectangles on construction paper. By using the decomposition method, they can compare the areas of plane figures.

2. Discuss the host's method of finding the area of a circle. The students could draw and decompose circles into rectangles.

3. The measurement of the area of larger surfaces such as playgrounds and sports-fields and irregular surfaces could be given as individual or group assignments.

PROGRAM 6

SURFACE MEASUREMENT PART II

This program is designed to develop the measurement of the surface area of solids.

PROGRAM CONTENT

By use of a planimeter, the host demonstrates how the areas of irregular surfaces such as areas on maps, are found. Again, a decomposition approach is used to find the surface areas of solids. A different approach is then used to find the surface area of curved surfaces such as spheres. Finally, the problem of finding the surface area of irregular solids, such as the human body, is presented. The need for estimation and approximation is shown.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Review the ellipse, sphere, cube and other solids.

2. The students could discuss reasons why the measurement of surface areas is required.

3. The students could consider methods of finding the surface area of the human body.

SUGGESTED POST-VIEWING ACTIVITIES

1. Using non-standard units of area, the students could find the areas of a variety of surfaces within the classroom.

2. With construction paper, the students could make their own cubes, icosohedrons, and decompose them to find their surface areas.

3. By using a grid, for example graph paper, the students could measure the area of such irregular shapes as leaves, areas on maps.

4. A discussion on various instruments for measuring length and area could be discussed following the program.

   The use of the planimeter* could be reviewed.

5. The students could reconsider question No. 2 of the pre-viewing activities.

***Reference**

ENCYCLOPEDIA BRITANNICA, Vol. 14, 1968 Edition. Page 1084c, see *Mathematical Instruments* description only. Also see Collier's Encyclopedia.

PROGRAM 7

VOLUME

The aim of this program is to introduce volume and the need for the measurement of volume of objects in everyday life.

PROGRAM CONTENT

This program introduces the concept of volume, although no hard and fast definition is used. Film-clips of everyday situations are shown to indicate the involvement of man with volume. The idea of a cubic unit of measure is presented in finding volumes of regular shapes such as rectangular boxes. The host then proceeds to show how the volume of solids such as cones, spheres might be found by processes of decomposition and displacement. Finally, the relationship between present day units of volume and those of early England is shown.

SUGGESTED PRE-VIEWING ACTIVITIES

A class discussion on the meaning of volume and the need for its measurement would be useful as an assignment.

SUGGESTED POST-VIEWING ACTIVITIES

1. A student or group, a report on

volume, its units of measure, and some everyday applications not mentioned on the program could be prepared.

2. Groups of students could be assigned such problems as finding the volume of objects in the classroom, school, home etc.

3. A selection of objects with assorted shapes, but all having the same volume, could emphasize the concept of volume.

PROGRAM 8

CAPACITY

This program is designed to relate the concept of capacity to everyday uses and distinguish it from volume.

PROGRAM CONTENT

By posing a series of rhetorical questions, the host shows the need for a different unit for the measure of liquids from that used in the program on volume (program no. 7). The historical derivation of today's units of capacity measure is traced from those of early England. Explanation is also given for the disparity between American and Imperial capacity measures. Finally the host uses a displacement vessel to measure the volume of the human body.

SUGGESTED PRE-VIEWING ACTIVITIES

1. A class discussion could be centered on how certain commodities are purchased, (e.g., in the supermarket) and the units used in their packaging.

SUGGESTED POST-VIEWING ACTIVITIES

1. A discussion centred around the *concept of solid* could follow the viewing of this program.

2. An old pint milk carton used as a displacement vessel could be made by the students in the following way: cut off the folded top portion of the carton, pierce a hole on one side and fit in a milk straw. To prevent leakage around the straw, seal with some heated paraffin wax. A second milk carton, cut a little lower, could be used as a catchment vessel, for measuring the water displaced.

3. Using the above displacement vessel, students could determine the volume of various objects in the classroom.

4. To show the students how the eye can be deceived by the shape of a container and its capacity, various shaped objects all with the same capacity could be used.

5. Students could make solids using triangles, squares and rectangles, and then be asked to ascertain their volume.

6. Research could be undertaken to determine how certain freight charges are arrived at on railways and freighters and what units of volume or capacity are used. The students could also be asked to see if they can detect an underlying reason for the various units used for these charges.

SERIES 2:

PROGRAM 9

MEASUREMENT IN ACTION

WEIGHT

This program will indicate the importance of weight and its accurate measurement in everyday life.

PROGRAM CONTENT

In order to demonstrate the importance of weight and weighing in everyday life, the program opens with film clips of situations where a "load limit" is imposed; e.g. at airports, sports events, the doctor's office. An experiment to show that objects with equal volumes do not necessarily have the same weight, illustrates the need for some accurate means of weight measure. Attention is drawn to the development of the balance and other scales. The principle of the balance is emphasized. The evolution of a standard unit of weight is shown through historical references, and the "avoirdupois" system is considered. In order to illustrate the importance of choosing an appropriate unit, the children are asked to consider which unit would be suitable for weighing such objects as an elephant, potatoes and spaghetti. The importance of accurate weight measurement in industry is shown. The program concludes with a student's trip in space to illustrate the concepts of gravity, weight and weightlessness.

SUGGESTED PRE-VIEWING ACTIVITIES

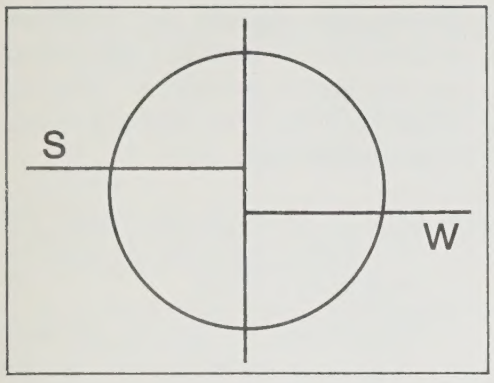
1. A discussion with the students could be centered around the relationship of volume and weight. The use of objects with the same volume, but different weights, or different volumes but the same weight would be a great asset to such a discussion.

2. A review of the terms fulcrum, equilibrium, and balance scale would be helpful to students viewing this program.

SUGGESTED POST-VIEWING ACTIVITIES

1. The following points could be discussed:

   - the maximum weight carried by an airplane passenger,
   - the need for "load limit",
   - the use of weighing scales in supermarkets and the need to check their accuracy; (Department of Weights and Measures),
   - the development of standard weights by ancient peoples – seeds and geometrical objects used as weights by the Egyptians,
     - weights in the forms of sleeping ducks and crouching lions,
     - "scale-weights" used in early England,
   - the confusion in trading due to the lack of a standard unit,
   - the meaning of "avoirdupois", and the origin of its units,
   - shipping costs usually depend on weight and volume,
   - why there are so many lines on the Plimsoll mark; e.g., for fresh water as well as salt water and the various shipping areas. (see illus. above)



– the reason why bathroom scales are marked "Not Legal for Trade",

2. A simple balance scale could be made.

   Non-standard units of weight could be used to measure the weight of various objects.

   A system of weights could be constructed from different colours of plasticine: e.g., 1-ounce, 2-ounce, 4-ounce weights.

3. The students could determine which standard units would be most appropriate to measure the weights of a wide variety of objects.

4. Compare the various measures by which food is sold – weight, dry measure, etc.

5. Compare a person's weight at different positions on the earth's surface or on other planets; e.g., at the equator, in Death Valley, on Mount Everest, on the moon, on Jupiter.

   What is weightlessness?

PROGRAM 10

TEMPERATURE

The aims of this program are to illustrate the various thermometers needed to measure the vast ranges in temperature; to indicate the vast ranges in temperature; and to point out the industrial importance of knowing temperature.

PROGRAM CONTENT

The program opens with an experiment designed to illustrate the drastic effect of extreme temperature changes: the host places a banana skin in a container of liquid nitrogen (temperature 300° below zero). He emphasizes how important it is for us to know the temperature of our surroundings and illustrates this with reference to the tobacco, dairy, lumber and shipping industries.

The host then explains how the principles of expansion and contraction of solids, liquids and gases are used in the measurement of temperature. The history of the Fahrenheit and the Centigrade scales is explained. The pyrometer, a device to measure extreme heat, is also shown. The principle of metal expansion is applied to thermostats and reference is made to the "built-in thermostats" of hibernating animals.

The program concludes with an explanation of weather charts. The final comment on crickets (add 40 to the number of chirps per minute to determine the temperature) is apparently true for the Snowy White cricket.

SUGGESTED PRE-VIEWING ACTIVITIES

1. The students could discuss ways in which their bodies react to changes in temperature e.g. shivering, perspiring, goose pimples.

2. A discussion could be centered around situations and areas where the students feel temperature is important.

SUGGESTED POST-VIEWING ACTIVITIES

1. The following points could be discussed:

   – the effect of liquid nitrogen on the banana peel,

   – the meaning of thermometer,

   – Galileo's thermometer, the "thermoscope",

   – the construction of the Fahrenheit and Centigrade thermometer,

   – the relative values of the Centigrade and Fahrenheit degree,

   – a comparison of the scales on medical and weather thermometers,

   – the thermostat: house, automobile,

   – the long metal foot on a meat thermometer.

2. Discuss the importance of knowing the temperature with regard to:

   – a tropical fish aquarium,

   – curing tobacco,

   – market gardening (greenhouses),

   – dairy farming,

   – preservation of frozen food,

   – shipping on the St. Lawrence River,

   – logging and paper industry,

   – baking,

   – weather forecasting (meteorology),

   – hospitals.

3. Discuss how the following principles are applied in the construction of thermometers:

   – Gases, liquids, and metals expand when heated, and contract when cooled.

   – Different metals have different rates of expansion.

4. The freezing and boiling points of some liquids used in thermometers are listed below:

Liquid	Freezing Point	Boiling Point
alcohol	-110°F	200°F
water	32°F	212°F
mercury	-38°F	686°F

   Discuss the advantages and disadvantages of using the above liquids in thermometers, e.g. Why wouldn't it be possible to measure the temperature of molten steel with a mercury thermometer?

5. Discuss the reasons why the following phenomena occur:

   – Railway tracks have gaps.

   – The ducts creak when the furnace heats.

   – There is sometimes a sharp hollow noise when the hot water is turned on.

   – Gaps are left between sections in the construction of long bridges.

6. The temperature of different cities, or countries could be examined, e.g. comparison of the average temperatures of Windsor, Ontario and Canberra, Australia.

7. Some students could be assigned to keep a record of temperatures in the classroom, and in the atmosphere outside, for a week. They should graph the results and interpret them in a written paragraph.

PROGRAM 11

ANGLE

The aim of the program is to examine the concept of angle, and its unit of measurement. The application of angle to latitude and longitude is considered in detail.

PROGRAM CONTENT

The program begins with a number of examples where angles can be seen in the environment. The host illustrates how semaphore is one application of angles and by using a flashlight, he examines the fundamental ideas of the angle. References are made to the ray and the vertex, and to the fact that the word 'angle' originates from the Latin word *angulus,* which means corner. A model is used to illustrate acute, right, obtuse, and straight angles. The program provides many examples of these in the environment and the students are given an opportunity to identify these angles in the visuals that are shown.

The question is raised as to what type of unit is used to measure angles. Reference is made to the Egyptian calendar, which had 360 days for a complete rotation around the sun. The degree is introduced as a unit to measure the angle. It is established that a right angle has 90 degrees and a straight angle 180 degrees. There is no attempt to teach the use of a protractor (to measure angles) but, in addition to the protractor, reference is made to other methods of measuring angles at sea and in industry. By means of a model the concepts of latitude and longitude to indicate positions on the earth's surface are described. The meaning of parallels of latitude and meridians of longitude is explained. For interest, reference is made to the Golden Plover, which crosses two thousand miles of open ocean from the Aleutian Islands and lands every time in Hawaii, and to the migrating Sea Turtles who swim from Brazil 1400 miles to nest in the Ascension Islands, apparently without means of navigation.

PRE-VIEWING ACTIVITIES

1. Examine different types of angles
2. Discuss the meaning of rotation
3. Examine globes and maps for latitude and longitude lines. (This is essential if the illustrations used in the program are to be of value).

SUGGESTED POST-VIEWING ACTIVITIES

1. The following points could be discussed from the program:
   - the angles involved in making semaphore symbols,
   - the meaning of ray, vertex,
   - the meaning of the Roman word *angulus,*
   - the meaning of acute, obtuse,
   - the use of the protractor to measure angles,
   - the Egyptian calendar with 360 days,
   - the relationship of one degree to a complete rotation.
2. Examine the environment for examples of acute, right, obtuse, and straight angles, and how they are used.
3. Construct a semi-circular protractor from cardboard:
   - with a clockwise scale,
   - with a counter-clockwise scale,
   - with both scales.

   Measure the values of acute, and obtuse angles obtained from such situations as angles made by clock hands, tree branches, furniture designs.
4. Discuss how latitude and longitude enabled man to establish a grid system on the earth's surface in order to locate positions. The following points could be discussed:
   - the use of angles to denote the meridians of longitude and the parallels of latitude,
   - the parallels of latitude are only marked up to 90 degrees but the meridians of longitude are marked up to 180 degrees,
   - the equator is used as the starting position for parallels of latitude; the starting line for the meridians of longitude passes through Greenwich in England,
   - locate positions in terms of latitude and longitude for cities on the different continents,
   - find the position on the earth's surface indicated by such readings as:

     10 degrees South – 17 degrees West

     45 degrees North – 48 degrees East.

PROGRAM 12

PRECISION

The aim of the program is to show that wherever there is a need for great accuracy, exactness or precision in measurement, man invents or develops instruments to help him.

PROGRAM CONTENT

The program opens with a film of a jet airliner landing at an airport in conditions of heavy fog. The host explains that the pilot and ground control depend upon complex precision instruments in order to land the aircraft safely since there is no margin for human error. He explains that the need for precision instruments is greater today than ever before owing to the accelerated speed of progress, and the demand for increasing efficiency in measurement. Among the various precision instruments shown are:

- stopwatch – records within 100ths of a second
- fathometer – measures the depth of the ocean and charts the ocean floor
- radio telescope – records electrical signals from outer space
- psychrometers and thermographs – measure and record humidity
- chemical – balance scale – weighs handwriting on paper
- tipping bucket – measures rainfall
- weather vanes, sunshine recorders
- devices to control hydro-electric energy
- dynamometer – measures automobile efficiency by duplicating road conditions
- precision instruments in medicine and surgery
- the electron microscope

The host notes that as new demands cause new developments, previous precision instruments come into general circulation, e.g. present day household appliances. The host speculates on precision tools of the future, such as laser beams, which measure in billionths of an inch, and concludes that limitations on measurement will be a significant factor in future development.

SUGGESTED PRE-VIEWING ACTIVITIES

1. Discuss the word `precision'
2. Discuss developments that would make the invention of new measuring instruments necessary, (e.g. in science, medicine, space, biology).

SUGGESTED POST-VIEWING ACTIVITIES

1. Discuss the necessity for any or all the precision instruments shown on the program, and the value of these instruments to mankind.
2. Discuss which precision instruments of today may be in current household use in the future.
3. "Invent" a precision instrument of measurement and describe the need it was intended to serve.

MATHEMATICS – Junior Division
MAN AND MEASUREMENT
12 programs, 20 minutes each

Note: Programs 13-18 in the Junior Math Series will be described in a separate Teacher's Guide. This Series is entitled "Concepts".

Prog. No.	CBC 9:10-9:30	CBLT 9:40-10:00	CHCH 9:10-9:30	CKCO 9:50-10:10	CJOH 9:10-9:30	CBOT 9:50-10:10	CKLW 10:20-10:40
1	OCT.16	JAN. 10	OCT. 15	OCT. 16	OCT. 18	OCT. 18 – 10:00-10:20	OCT. 23
2	OCT. 18	JAN. 17	OCT. 18	OCT.18 – 9:30-9:50	OCT. 25	OCT. 21	OCT. 25 – 10:00-10:20
3	OCT. 23	JAN. 24	OCT. 22	OCT. 23	NOV. 1	OCT. 23 – 10:00-10:20	OCT. 30
4	OCT. 25	JAN. 31	OCT. 25	OCT. 25 – 9:55-10:15	NOV. 8	OCT. 28	NOV. 1 – 10:25-10:45
5	OCT. 30	FEB. 14 – 9:55-10:15	OCT. 29	OCT. 30	NOV. 15	OCT. 30 – 10:00-10:20	NOV. 6
6	NOV. 6	FEB. 21 – 10:15-10:30	NOV. 5	NOV. 6	NOV. 22	NOV. 4	NOV. 13
7	NOV. 13		NOV. 12	NOV. 13	NOV. 29	NOV. 13 – 10:00-10:20	NOV. 20
8	NOV. 20		NOV. 19	NOV. 20	DEC. 6	NOV. 18	NOV. 27
9	NOV. 27 JAN. 22		NOV. 26 JAN. 21	NOV. 25	DEC. 13	NOV. 25	DEC. 2
10	DEC. 4 JAN. 29		DEC. 3 JAN. 28	DEC. 2	DEC. 20	DEC. 2	DEC. 9
11	DEC. 11 FEB. 19		DEC. 10 FEB. 11	DEC. 9	JAN. 13	DEC. 9	DEC. 16
12	DEC. 18 FEB. 26		DEC. 17 FEB. 25	DEC. 16	JAN. 20	DEC. 16	JAN. 6

MATHEMATICS: JUNIOR DIVISION